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1890/91

THE

SCHOOL OF MINES

OF THE

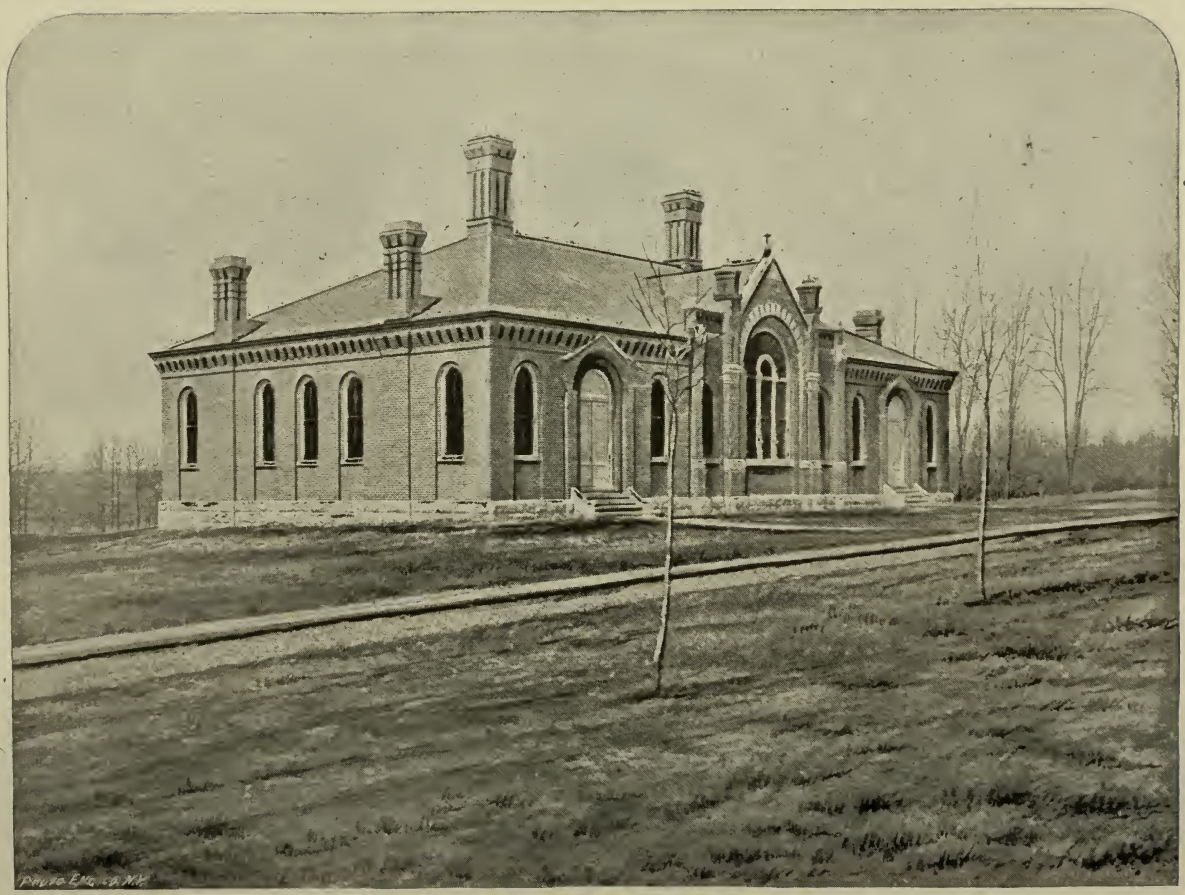
University of Missouri.

CATALOGUE,

1890-91.

J. E. MANGAN PRINTING CO.,
1007-9-11 LOCUST STREET, ST. LOUIS.
1891.

COLLEGE BUILDING.



LABORATORY.

MESS-CLUB HOUSE.

'WORK IS VICTORY."

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INTRODUCTORY STATEMENT.

THE School of Mines and Metallurgy is an Institute of Technology, a College of Engineering with Civil and Mining Engineering and Metallurgy as specialties. It is a College of the University of the State of Missouri, and is located at Rolla, Phelps County, on the line of the St. Louis and San Francisco Railway, about one hundred miles southwest of St. Louis. The location, pre-eminently healthful, is in the midst of an extensive and rapidly developing iron section with districts abounding in lead and zinc deposits within easy access, and thus affords excellent opportunities for the field study of the modes of occurrence of the ores of these metals as well as for the practical investigation of their methods of treatment.

In 1889 a course in Mechanical Engineering was organized and added to the professional work of the institution. It is intended to develop this department fully with the view of a mechanical laboratory and machine shops in which thorough and practical instruction may supplement the class work in the Theory of Machinery and Mechanical Engineering.

In addition to the three courses of professional instruction, the college now offers three additional courses in special scientific work, each leading to the degree of Bachelor of Science.

It is the design of the School to give, in its special lines of work, instruction that is as complete and as exhaustive as may be attained, at once practical and thorough, based on scientific principles. Its diplomas are granted only to those who win them by honest, earnest and successful work. Throughout the course, thoroughness and a high standard of excellence is

constantly held in view, and no effort is neglected which may tend to secure to the student a training which may enable him to become a successful engineer or to reach a place among the educated scientists of the present day.

In order to maintain the high standard of the institution, it was found necessary to establish a preparatory department in which young men inadequately prepared could be trained to meet the requirements of the advanced work. This course is still maintained for the benefit of those who may wish to prepare themselves here for the work in the higher courses.

At the session of 1887 of the Legislature of Missouri a bill was passed providing for the establishment of an academic course of study at the School of Mines. In pursuance of the provisions of this act the Academic Department was therefore organized, and a general course in Academic instruction is offered as outlined in the exhibit of the Academic Course.

Following the example of the Massachusetts Institute of Technology and the opinion of the American Society of Civil Engineers, it has been decided by the Faculty of the School of Mines to no longer confer the degree of Civil, Mining or Mechanical Engineer immediately on graduation, but to confer on graduation the degree of Bachelor of Science in Civil Engineering, Mining Engineering or Mechanical Engineering; and after a stated interval of time, during which the graduate has thoroughly identified himself with the profession, he may receive upon application to the Faculty the full degree in Civil, Mining or Mechanical Engineering.

SCHOOL OF MINES AND METALLURGY.

ROLLA.

REPORT OF THE COMMITTEE APPOINTED BY THE GOVERNOR TO VISIT AND EXAMINE THE STATE UNIVERSITY.

"WORK is Victory" stands as the motto of this department of the State University, and the new life infused into it within two years gives promise of a brilliant future. It is not to be denied that this school has failed in the past to come up to the full measure of the expectation of those who secured its establishment. This was chargeable partly to the lack of systematic work on the part of the Faculty, partly to the failure of the management of the University to give it hearty support, and largely to the General Assembly. Great results were expected of an institution which was not supplied with proper facilities for carrying out the work demanded. The first step in the direction of properly equipping the school was made in 1885, when an appropriation was made for building and equipping a chemical laboratory. This enabled the school to take front rank in chemical work of all kinds, and the good results that followed warrant the assumption that with complete equipment the school would soon take its proper position among the great scientific institutions of the country.

The school has been reorganized during the biennial period on a practical basis, and we now regard it as a school of the highest utility and intellectual attainments, and recommend that it be provided with proper equipment. Appropiations should be made for a metallurgical laboratory and also for a building for the engineering department. The necessity of these will be fully set out in the reports of the school.

The Thirty-fifth General Assembly appropiated $5,000 to

build a club-house for this school. The money was expended under the direction of Architect H. Hohenschild, of Rolla, and the building is a credit not only to the school and architect, but to the State as well. Unless we except the chemical laboratory at this institution, we are satisfied that no money ever appropriated by the State for building purposes has been more judiciously expended.

The Board has expended about $5,000 from the funds of the institution in repairing and repainting the school building, grading and fencing the park, putting in new walks, digging wells, etc., and now has the entire property in excellent condition. The money has been wisely invested.

To the criticism sometimes made on this school for not having a greater number of graduates each year, your committee deem it but just to say that, in our opinion, this is largely due to three facts: 1st, that the facilities have not been provided for a complete education in all the branches of scientific knowledge expected to be taught here, without more time, labor and expense than the average student of limited means can afford; 2d, that work and proficiency alone are the touchstones to the success rewarded by diplomas from this school; 3rd, that the demand for students who have not more than half finished the prescribed course required by this school before graduation, but who have become equipped for the work of surveyors and civil engineers to the extent that they command much greater wages than they could have done on entering the school, tempts many to make engagements that lead them away from the school before finishing the course, most of these students being of limited means.

JOHN C. PIERSOL,
W. E. PERKINSON,
GROVES M. LANE,
} Committee.

COURSES OF INSTRUCTION.

THE School of Mines and Metallurgy of the University of Missouri in order to meet most fully the designs of its establishment as expressed in the Act of the Legislature founding it, namely, "to teach such branches as are related to the mechanic arts and mining, without excluding other scientific and classical studies, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life," and in the supplemental Act of the Legislature of 1887 instituting an Academic Course, offers the followlng regular Courses of Instruction:

I. Mining Engineering.
II. Civil Engineering.
III. Mechanical Engineering.
IV. Chemistry.
V. Mathematics and Physics.
VI. General Scientific Course.
VII. Academic Course.
VIII. Preparatory Course.

Courses I and II are the Professional Courses about as now established. Course III is a Professional Course introduced the present session. Courses IV and V present an opportunity to pursue fully special lines of scientific work. Course VI is, as its name indicates, a general scientific course, including a greater variety of subjects than either of the preceding, but with relatively smaller requirements in each. Course VII is the Academic Course as at present maintained.

For the satisfactory completion of any of the courses I–VI, inclusive, the degree of Bachelor of Science in the course pursued is conferred. In the Professional courses I, II and III, as stated elsewhere, the degree of Mining, Civil or Mechanical Engineer is, in accordance with the best usage of the day, conferred only upon certain conditions subsequent to graduation. For the completion of Course VII a Certificate of Proficiency in the Academic Course is bestowed, but no titled degree is given.

To pursue successfully the studies of any of the Baccalaureate Courses, I–IV, a thorough knowledge of Elementary Algebra and Geometry is essential, and for most of them a similar acquaintance with the elements of Physics and Chemistry is highly desirable, if not equally necessary. The Preparatory Course (VIII) is maintained for the benefit of those who lack such preparation. Students who finish this course receive a certificate stating the fact of such completion. Experience has shown that frequently valuable time is wasted by men in attempting the higher work without having adequately grasped preliminary subjects, and, hence, to guard against the disappointment that must almost inevitably follow such misdirected efforts, it will in the future be required as a condition of entrance upon the work of any of the courses, I–V, inclusive, that applicants must either have done the work of the Preparatory Course here, or have stood an examination upon its equivalent in Mathematics at least.

The work of the College is distributed among the five schools of Mining, Civil and Mechanical Engineering, Analytical Chemistry and Metallurgy, Pure Mathematics, Mineralogy and Geology, and Physics, and an Academic and a Preparatory department. At present instruction in Mineralogy and Geology is given by the Professor of Chemistry. The elementary work of Physics is chiefly carried on in the Preparatory department, while the course in Analytic Mechanics is now assigned to the School of Engineering.

Below will be found a scheme of the studies in each course. By comparing this schedule with the subsequent statements of the work in the individual schools, the character and

amount of the requirements in each case may be learned. Applicants for degrees are invariably required to complete here the full amount of work as prescribed, in order to obtain the degree. While the work of each course is distributed among three distinct classes, each extending through one year, the degree is conferred not for attendance during any definite or indefinite period of time but for actual work done. Thus, in exceptional cases, a man who is well prepared and capable might by diligence attain the degree in two years.

Outside of the regular degree courses, students may take special courses in Engineering, Assaying, Chemistry, or Mathematics, and will be given certificates for the amount and quality of work performed.

SCHEDULES OF STUDIES.

I.—COURSE OF STUDY IN MINING ENGINEERING.

JUNIOR CLASS.

Trigonometry,
Analytic Geometry,
General Chemistry,
Blowpipe Analysis,
Determinative Mineralogy,
Qualitative Analysis.
Descriptive Geometry,
Engineering Instruments.
Drawing.
Field Work.

INTERMEDIATE CLASS.

Solid Analytic Geometry,
Differential Calculus,
Integral Calculus,
Chemical Technology,
Mineralogy and Geology,
Qual. and Quan. Analysis,
Geodesy.
Exploitation of Mines.
Drawing.
Assaying.
Field Work.

SENIOR CLASS.

Metallurgy,
Qualitative Analysis,
Applied Mechanics,
Quantitative Analysis,
Assaying.
Thesis.

II.—COURSE OF STUDY IN CIVIL ENGINEERING.

JUNIOR CLASS.

Trigonometry,
Analytic Geometry,
General Chemistry,
Blowpipe Analysis,
Determinative Mineralogy,
Descriptive Geometry,
Engineering Instruments,
Drawing,
Field Work.

INTERMEDIATE CLASS.

Solid Analytic Geometry,
Differential Calculus,
Integral Calculus,
Mineralogy and Geology,
Geodesy,
Engineering Constructions,
Lines of Communication,
Drawing,
Field Work.

SENIOR CLASS.

Analytical Statics,
Applied Mechanics,
Materials of Construction,
Drawing,
Stability of Structures,
Hydraulic Engineering,
Field Work,
Thesis.

III.—COURSE OF STUDY IN MECHANICAL ENGINEERING.

JUNIOR CLASS.

Trigonometry,
Analytic Geometry,
General Chemistry,
Blowpipe Analysis,
Determinative Mineralogy,
Descriptive Geometry,
Engineering Instruments,
Drawing,
Field Work.

INTERMEDIATE CLASS.

Solid Analytic Geometry,
Differential Calculus,
Integral Calculus,
Mineralogy and Geology,
Physics,
Statics,
Kinematics of Machinery.

SENIOR CLASS.

Strength of Materials,
Dynamics,
Mechanics of Machines,
Theory of Prime Movers,
Thesis.

IV.—COURSE OF STUDY IN CHEMISTRY.

JUNIOR CLASS.

General Chemistry,
Blowpipe Analysis,
Determinative Mineralogy,
Qualitative Analysis,
German.

INTERMEDIATE CLASS.

Qualitative Analysis,
Quanitative Analysis,
Assaying,
Chemical Technology,
Mineralogy and Geology,
German.

SENIOR CLASS.

Metallurgy,
Qualitative Analysis,
Quanitative Analysis,
Assaying,
Thesis.

V.—COURSE OF STUDY IN MATHEMATICS AND PHYSICS.

JUNIOR CLASS.

Trigonometry,
Analytic Geometry,
Descriptive Geometry,
Physics,
French or German.

INTERMEDIATE CLASS.

Solid Analytic Geometry,
Differential Calculus,
Integral Calculus,
Statics,
Kinetics,
Dynamics,
French or German.

SENIOR CLASS.

Projective Geometry,
Theory of Equations,
Differential Equations,
Determinants,
Quaternions,
Statics,
Dynamics,
Sound, Light, Heat, or Electricity,
Thesis.

VI.—COURSE OF STUDY IN GENERAL SCIENCE.

JUNIOR CLASS.

Higher Algebra,
Geometry,
History,
French or German,
Composition and Rhetoric.

INTERMEDIATE CLASS.

Trigonometry,	Geology,
Analytic Geometry,	Physics,
Physical Geography,	French or German.

SENIOR CLASS.

General Chemistry,	Political Economy,
Botany and Zoology,	English Literature,
Astronomy,	Thesis.

VII.—ACADEMIC COURSE.

FIRST YEAR.

First Term.

Mathematics, ... Arithmetic and Algebra.
Language, ... English Grammar.
History, ... U. S. History.

Second Term.

Mathematics, ... Arithmetic and Algebra.
Language, ... Composition and Rhetoric.
Science, ... Physical Geography and Physiology.

SECOND YEAR.

First Term.

Mathematics, ... Geometry.
Language, ... French, or German.
Science, ... Physics.

Second Term.

Mathematics, ... Geometry.
Language, ... French, or German.
History, ... General History.
Science, ... Civil Government.

THIRD YEAR.

First Term.

Language, ... French, or German.
Literature, ... English Literature.
History, ... English History.

Second Term.

Language, ... French, or German.

Science, ... { Chemistry. Botany. Political Economy. Book-keeping (optional).

VIII.—PREPARATORY COURSE.

FIRST YEAR.

First Term.

Mathematics, ... Higher Arithmetic and Algebra.
Language, ... English Grammar.
History, ... U. S. History.

Second Term.

Mathematics, ... Algebra.
Language, ... Composition and Rhetoric.
Science, ... Physical Geography.

SECOND YEAR.

First Term.

Mathematics, . . Higher Algebra, and Geometry (Plane).
Science, ... Physics.

Second Term.

Mathematics, . . Higher Algebra, and Geometry (Space).
Science, ... Chemistry and Physics.

SCHOOL OF ENGINEERING.

PROF. W. H. ECHOLS.

The School is organized with a view to acquaint the student *familiarly and practically* with the principles of his profession. The instruction is as thorough as possible, and is given partly through text books and partly through lectures, with daily examinations upon both. A high standard of excellence in attainments is rigidly adhered to and required for the satisfactory completion of the course.

The work of this School is distributed among three departments of engineering, namely, the Civil, Mining and Mechanical branches of the profession, as follows:

CIVIL ENGINEERING.

The work of this department is distributed among the three classes:

JUNIOR.

1. *Descriptive Geometry.*—Theory of Parallel Projections, Orthogonal, Axonometric and Oblique, with the Construction of Shades and Shadows. Theory of Central Projections, or Linear Perspective.

2. *The Instruments.*—The instruments of the engineer, both field and office, are considered in order—their principles, details, construction, adjustment and uses.

3. *Drawing.*—The easy and accurate use of pen and brush is first acquired by exercises, and developed by application to projective drawings, shading and shadows; lettering.

4. *Field Work.*—The members of the Junior Class enter the corps with the grade of Rodmen, and are required to do duty in that capacity before being advanced.

INTERMEDIATE.

1. *Engineering Geodesy.*—Theory and descriptions of the engineering field instruments, their uses, capabilities, measures of approximation and of precision are thoroughly discussed and applied in the measurement of horizontal and vertical

distances and angles; general and particular methods and problems in traversing; triangulation, direct and indirect leveling; land, city, orographic and hydrographic surveying; government and engineering geodetic work; tachymetric processes.

2. *Engineering Construction.*—Surface excavation and mensuration of same; construction of shafts and tunnels; foundations on land and under water; materials of construction—timber, stone, brick, mortars and cements, and iron; building construction.

3. *Lines of Communication.*—Preliminary survey, location and construction of railways, highways, streets, canals, tunnels and bridges.

The greater portion of half the session being devoted to the study of Railroad Engineering, every effort is made to insure this part of the course being of the highest practical value to the student possible.

4. *Drawing.*—The applications of projective geometry to stone cutting; the projections, templats and directing instruments for same; and to spherical projections; working draughts of engineering structures, such as piers, foundations, wing walls, abutments, coffer-dams, caissons, trestles, mine timbering, etc., in all their details; construction of maps.

5. *Field Work.*—The members of the Intermediate Class rank in the corps as instrument men, and in the field acquire practical knowledge of the use of all the field instruments of the engineer, including the compass, barometer, level, transit, solar, stadia and plane table.

SENIOR.

1. *Engineering Mechanics.*—General theory of force, stress, strain, energy, and hydraulics, with applications to the analysis of structures; to the design of the elements of structures and machines; pipes for water, air and steam; ditches, flumes, and canals for water, etc.

2. *Stability of Structures.*—Amount and distribution of load on structures; stability of elementary structures, the

girder, the cable, the arch, the pier, with applications to the design of bridges, roofs, buildings, dams, abutments, arches, revetments, etc.

3. *Hydraulic Engineering.*—Collection and filtration of potable water; conveyance of water, either by gravity or pumping; drainage, sewerage and water supply of cities and towns; disposal of sewage.

4. *Drawing.*—The application of graphical analysis to the solution of statical problems of design, the stresses in structures; lines of resistance in dams, arches, and piers; finished drawings, with colors and shadows in connection with the structures designed, their details in full; topographical maps.

5. *Field Work.*—The members of the Senior Class enter the field as chiefs of parties, and it is under their direction and charge (subject to the professor's instruction) that the corps carries on the prescribed field work and surveys.

MINING ENGINEERING.

The work of this department is carried on in three classes as follows:

JUNIOR.

1. *Descriptive Geometry.*—Theory of Parallel Projections, Orthogonal, Axonometric and Oblique, with the construction of Shades and Shadows. Theory of Central Projections, or Linear Perspective.

2. *The Instruments.*—The instruments of the engineer, both field and office, are considered in order—their principles, details, construction, adjustments and uses.

3. *Drawing.*—The easy and accurate use of pen and brush is first acquired by exercises, and developed by application to projective drawings, shading and shadows; lettering.

4. *Field Work.*—The members of the Junior Class enter the corps with the grade of Rodmen, and are required to do duty in that capacity before being advanced.

INTERMEDIATE.

1. *Engineering Geodesy.*—Theory and descriptions of the engineering field instruments, their uses, capabilities, measures of approximation and of precision are thoroughly discussed and applied in the measurement of horizontal and vertical distances and angles; general and particular methods and problems in traversing; triangulation, direct and indirect leveling; land, city, orographic and hydrographic surveying; government and engineering geodetic work; tachymetric processes.

2. *Engineering Construction.*—Surface excavation and mensuration of same; construction of shafts and tunnels; foundations on land and under water; materials of construction—timber, stone, brick, mortars and cements, and iron; building construction.

3. *Exploitation of Mines.*—Ore deposits in beds, lodes, placers and pockets; location and attack by shaft, incline and adit; underground transport in galleries, inclines and shafts; drainage by adits or pumps; ventilation by furnace or blowers; lighting; and mechanical concentration of ores.

4. *Drawing.*—The applications of projective geometry to stone cutting; the projections, templets, and directing instruments for same; and to spherical projections; the representations of underground workings of mines in plan, elevation and axonometric projections; working draughts of engineering structures, the simpler machines used in mining and ore dressing and concentration, hoists, cages, tramways. The draughting of maps, flat and topographical, geological sections and sketch views of the terrain.

5. *Field Work.*—The members of the Intermediate Class rank in the corps as instrument men and in the field acquire practical knowledge of the use of all the field instruments of the engineer, including the compass, barometer, level, transit, solar, stadia and plane table. Particular attention is given to the field work of the United States Deputy Mineral Surveyor and the use of the solar instrument.

SENIOR.

1. The work of this class consists of a prescribed course in Statics, Dynamics and Mechanics, with application to the simple engineering structures and the principles of design and strength of materials.

MECHANICAL ENGINEERING.

The work of this department is also carried on in three classes:

JUNIOR.

1. *Descriptive Geometry.*—Theory of Parallel Projections, Orthogonal, Axonometric and Oblique, with the Construction of Shades and Shadows. Theory of Central Projections, or Linear Perspective.

2. *The Instruments.*—The instruments of the engineer, both field and office, are considered in order—their principles, details, construction, adjustments and uses.

3. *Drawing.*—The easy and accurate use of pen and brush is first acquired by exercises, and developed by application to projective drawings, shading and shadows; lettering.

4. *Field Work.*—A knowledge of the simple field operations is required of these students, as well as proficiency in the use of the engineers' transit and level.

INTERMEDIATE.

1. *Class Work.*—The previous course in Physics is here supplemented by a full course in Physics, Statics, Dynamics and Kinematics strictly with reference to the needs of the Mechanical Engineer.

2. *Drawing.*—The drawing board is in constant use throughout the year, the student making use of his previous training in constructing drawings of machinery, in shading casting shadows and coloring the same, and making graphical constructions of physical problems.

SENIOR.

1. *Engineering Mechanics.*—General theory of force, stress, strain, energy, and hydraulics, with applications to the analysis of structures; to the design of the elements of structures and machines; to thermodynamics and the theory of heat engines; to the design of flywheels, governors, etc.; pipes for water, air and steam; ditches, flumes and canals for water, etc.

2. *Mechanics of Machines.*—Theory of gearing, simple and compound; constructive mechanism, including the design of machines; efficiency of mechanism; regulators, including brakes; accumulators, governors and valves; transmission of energy and power, teledynamic, pneumatic and electric.

3. *Theory of Prime Movers.*—Hydraulic engines, water wheels, turbines and pumps; steam engines, including the design of the furnace, the boiler, the condenser and the engine proper; pneumatic engines and blowers; electric engines and dynamos.

4. *Drawing.*—The application of Graphical Analysis to the solution of Statical problems of design and mechanism. The finished drawings of designed machinery, details of construction, etc., etc.

A course of parallel reading of monographs, by the best authors (with which the library is abundantly supplied) is prescribed in connection with the lectures and the subject matter included in the examination papers. The best engineering periodicals of America, England and France are taken by the department, and are always at the disposal of the student, who is constantly referred to them and urged to read them. A feature of the work in the Engineering School is weekly meeting of the Quiz Club, in which the current articles in the engineering journals are discussed, and other topics relating to the professional work made familiar through discussion by the members. In the field work the student is thoroughly drilled in the best methods of survey and location known in modern practice. Expert and rapid manipulation of all the field instruments of the engineer is insisted upon; accuracy combined with rapidity is the essential feature. In the drawing-room the student is steadily employed throughout

the course in every variety of pen work of which the engineer makes use. In projective geometry the course is extensive and thorough, and assiduous use of the drawing board is necessary for success. Especial attention is given to the Graphical Statics, and to the solution of engineering problems by aid of the graphical processes. In design, specifications are furnished the student and written theses required, showing the design accompanied by all the necessary computations (arithmetical and graphical), finished drawings of the structures and details of the pieces, with working draughts for workmen. Particular stress is laid upon railway engineering as practiced in this country in all its details of preliminary survey, location and construction. In all the work of the department the student is encouraged to think for himself, to acquire confidence in what he knows to be correct, and to depend upon his own resources, to grasp subjects and not text-books.

In the absence of a professor for the chair of Physics, instruction in Analytical Mechanics is given in the department. Todhunter's Analytical Statics, New Edition, and Williamson's Dynamics are gone through in the beginning of the Senior year, thus preparing the student to take firm hold of the Applied Mechanics of the Engineering School.

While the degree courses as laid down will be strictly adhered to for all who apply for the degrees, special students may pursue any particular course which they may elect and receive certificates therefor. Men who have neither the time nor the means to enable them to take the full engineering course will find it advantageous to concentrate a year's work upon some special branch of the profession.

Text Books.—Church's and Waldo's Descriptive Geometry, with La Gournerie, Wiener and Breithof for reference. Rankine's Works, Cotterill's Applied Mechanics, Lanza's Applied Mechanics, DuBois' Graphical Statics, Chalmer's Graphical Determination of Forces in Engineering Structures, Callon's Lectures on Mining, André's Coal Mining, Kennedy's Mechanics of Machinery, Perry's Steam, Herrmann's Graphical Statics of Mechanism, Trautwine's or Molesworth's Pocket-book, Searle's or Henck's Field-book.

SCHOOL OF PHYSICS.

In the absence of a professor for this very important school the advanced work of the department is carried on by the Professor of Engineering, while the lower work is done by Mr. Wilkins.

In the Preparatory Department one year's work is given to Elementary Physics. The class meets five times each week throughout the session.

The object of the work here is to furnish the student with an introduction to Modern Physics, and to acquaint him with its methods of investigation. With the design of laying a thoroughly scientific basis for the course, a large space is given at the outset to the discussion of the cardinal doctrines of motion, force, energy, and potential, and to their simpler applications in the pressure and motion of visible masses.

With this preparation the student proceeds to the subject of Molecular Physics, embracing Sound, Light, Heat, and Electricity. Throughout the course the laws of motion and force are kept steadily in view, and an attempt is made to exhibit the evidence, daily becoming stronger and clearer, for the belief prevalent among scientists that the entire body of Physics is a coherent and harmonious system of mechanical truth.

In the School proper there are three classes in Physics extending through three years of progressive work.

JUNIOR CLASS.

The work of this class covers the same ground as that of the preparatory class. The treatment is wider and deeper. The popularization of the subject is now laid aside for the spirit of investigation, and Elementary Physics is gone into more extensively and a larger knowledge of pure mathematics required of the student. Those having a working knowledge of Trigonometry and Analytical Geometry take this class without having previously had the lower one. It is, however, advisable to take the two together.

INTERMEDIATE CLASS.

This class begins with the study of Mechanics and reads some such text book as Bowser's during the first half year. This is all that is required of engineering students. Special students in Physics then read Statics (Todhunter or Minchin), Kinematics (Minchin), Dynamics (Williamson, Pirie, Routh).

SENIOR CLASS.

The work of the preceding class may be extended into this year, or the student may devote himself to the mathematical treatment of one or more of the following subjects: Sound, Light, Heat, Electricity, Elasticity or Motion of Fluids.

It is to be hoped that the next Legislature may appropriate necessary funds for the purpose of erecting a physical laboratory, a feature much needed in the institution.

SCHOOL OF ANALYTICAL CHEMISTRY AND METALLURGY.

PROF. CHASE PALMER, MR. A. J. STEWART.

The courses in this school have been especially arranged to supply the needs of those who wish to prepare themselves for positions as Assayers, Chemists, and Mining Engineers. Students who are desirous and capable of accomplishing special lines of work, may arrange for such courses in Analytic Chemistry and Assaying as are adapted to their special requirements.

Instruction in the following courses is regularly given each session:

I. GENERAL CHEMISTRY.
II. CHEMICAL TECHNOLOGY.
III. METALLURGY.
IV. BLOWPIPE ANALYSIS AND DETERMINATIVE MINERALOGY.
V. ANALYTIC CHEMISTRY.
VI. ASSAYING.

1. *General Chemistry.*—The instruction in this course is communicated to the members of the Junior Class by means of lectures and recitations based upon Watt's edition of Fowne's Chemistry. The course includes the subjects of Chemical Physics, Chemical Philosophy and Inorganic Chemistry, and, in addition thereto, regular weekly exercises in Stoichometry and other problems of a chemical nature. The class meets three times a week throughout the session.

2. *Chemical Technology.*—The Intermediate Class meets three times a week throughout the session. Instruction is communicated by lectures and recitations based upon Wagner's Chemical Technology. The general principles involved in the smelting and treatment of the ores of the metal are first considered; followed by a description and explanation of the processes employed in the manufacture of Acids, Salts, Glass, Paper, Mortar, Cements and other Building Materials, Sugar, Wine, Spirits, Oils, Paints, Soaps, Bleaching Materials, Fuels, etc., etc.

The school is at present but poorly supplied with the models, drawings and specimens necessary for thorough instruction in the above subjects, but it is hoped that the additions which are constantly being made to its equipment will eventually make it approach to what it should be.

3. *Metallurgy.*—In addition to the brief course required of the Intermediate Class, the members of the Senior Class meet weekly for the discussion of assigned topics in the Metallurgy of Gold, Silver, Copper, Zinc, Lead and Iron. Special topics are assigned to each student, upon which he is required to prepare a paper embodying the results of his reading in the authoritative works on Metallurgy, with which the Library is well supplied; these papers are taken up in class and critically discussed by the other students.

Works of Reference.—Crooke's and Rohrig's, Percy's, Eggleston's and Phillip's works on Metallurgy; Bell's Iron Smelting and the transactions of the American Institute of Mining Engineers.

4. *Blowpipe Analysis* and *Determinative Mineralogy.*—This class meets regularly three times each week throughout the session for instruction and practice. Previous to beginning regular practice with the blowpipe each student is required to complete a series of experiments designed for preliminary training in chemical manipulations and to illustrate the properties of the more important chemical elements and the nature of chemical reactions. After which salts, oxides, and alloys are given to each student, on whose composition as determined by blowpipe tests alone he is required to report. This work is followed by a course of exercises in Determinative Mineralogy.

TEXT BOOK.—Erni's Blowpipe Analysis and Determinative Mineralogy.

5. *Analytic Chemistry.*—This course is begun with a series of selected exercises in Qualitative Analysis. These exercises, at first simple, are made more and more complex as the skill of the student increases. After a student attains sufficient skill to enable him to determine with a fair degree of accuracy the composition of substances given him he is allowed to begin Quantitative Chemical Analysis. In connection with this work, the student is required to complete one exercise each week in Qualitative Analysis as long as he remains in the Laboratory.

In order to complete the full course in Quantitative Chemical Analysis, each student must complete satisfactory analyses of the following substances:

1. Zinc Sulphate.
2. Barium Chloride.
3. Potassium Aluminum Sulphate.
4. Copper Sulphate.
5. Di-Sodic Phosphate.
6. Strontiam Nitrate.
7. Ammonia—Ferric Sulphate.
8. Fluor-spar.
9. Manganese Carbonate.
10. Nickel Ammonium Sulphate
11. Limestone.
12. Galenite.
13. Chalcopyrite.
14. Stibnite.
15. Arsenopyrite.
16. Cerussite.
17. Calamine.

18. Orthoclase.
19. Kaolin.
20. Chromite.
21. Hematite.
22. Cast Iron.
23. Spelter.
24. Lead.
25. Regulus.
26. Blast Furnace Slag.
27. Lead Furnace Slag.
28. Pyrolusite.
29. Bleaching Powder, valuation.
30. Soda Ash, valuation.
31. Coal, proximate, ultimate and heating power.
32. Borax.
33. Beryl.
34. Potable Water.
35. Mineral Water.
36. Guano.
37. Super-phosphate.
38. Sugar.
39. Potassium Ferrocyanide.

Applicants for the degree of Mining Engineer omit all after No. 28.

TEXT BOOKS.—Fresenius' Qualitative and Quantitative Analysis.

6. *Assaying.*—The course in Assaying begins with the second term of the second class, usually about February 1. This work is usually completed in five months.

Special attention in this course is given to the rapid estimation and valuation of ores and furnace products, both by the fire and wet assay.

FIRE ASSAYS. Gold and silver ores, also mill checks, are made the subjects of special study, and assays both by the crucible and scorification methods are required. Lead and copper ores are assayed by fire methods applicable to the ores in question.

WET ASSAYS.—Volumetric methods are carefully studied and applied to the rapid determination of copper, zinc, iron, etc., etc.

TEXT BOOK.—Rickett's Assaying.

Special students may pursue at their discretion the study and analysis of any class of ores or metallurgic products. Young men who have neither the time nor means to spare to take the full course may accomplish much in the way of chemical analysis and assaying by devoting their entire time to it during a single year.

All laboratory students furnish their own blowpipes, platinum, crucibles and apparatus, silver and gold solutions, and pay for gas and fuel consumed and for apparatus damaged or broken.

A deposit of $5 per term, covering the value of the apparatus and chemicals issued, is required to be placed in the hands of the Treasurer by each laboratory student. This deposit, less the value of material consumed, is returned at the close of the year.

THE NEW CHEMICAL LABORATORY.

The new Chemical Laboratory has been in use four years, and has been found satisfactory in every respect. It was planned and built solely with reference to the work in the school, and the entire building is used by the Chemical Department.

In this building there are the following departments: The quantitative laboratory; the qualitative laboratory; director's laboratory; lecture room; assay laboratory and weighing room; a quantitative and qualitative evaporating room; preparation room; a supply room, and two basement rooms, furnishing accommodations for seventy-five students.

In the construction of this laboratory no pains were spared to make the assay laboratory complete in every respect. It is located on the first floor and not in the basement. The reduction furnace as well as the muffle furnaces are of the newest and best. The large muffle furnace holds four muffles. An ore crusher, pulverizing-plate, with other facilities, are provided for the use of students.

Facilities for securing heat, light and ventilation are very perfect; ample provision is also made for carrying off foul and dangerous gases. All parts of the building are thoroughly and judiciously equipped; nothing has been left undone to make this laboratory one of the most complete in the country. Gas and water are supplied to each table.

The laboratory contains, in addition to a large assortment of the apparatus regularly and ordinarily met with in well equipped institutions, one of Becker's Lithological Microscopes, Contact and Reflecting Goniometers, Dynamo for experimental work in Electrolysis, and other valuable pieces of apparatus for work and research.

The Chemical Laboratory is open to students for work daily from 8 A. M. to 5 P. M.

SCHOOL OF MINERALOGY AND GEOLOGY.

The instruction on these subjects is communicated to the members of the Intermediate Classes.

Models, diagrams and natural crystals are used in imparting a knowledge of the principles of Crystallography. Systematic Mineralogy is taught in conjunction with exercises in Determinative Mineralogy.

In addition to the usual course in Physical Geography, Dynamical, Structural and Historical Geology, special attention is given to Chemical and Economic Geology. The course of instruction embraces the origin of vein stones and ore deposits, mineral waters, coal, petroleum and natural gas.

SCHOOL OF MATHEMATICS.

PROF. RICHARDS.

Great importance is attached to the study of Mathematics wherever it forms a part of the curricula. The School offers beyond the Preparatory Course, which completes Algebra and Geometry, three years' work, different amounts of which, as will be seen by the subsequent statements, are required in different courses. In order to enter the Junior Class, which begins with Trigonometry, the student must either have completed the Preparatory Course here or must stand a satisfactory examination upon as much Mathematics as is contained in it. No Mathematics beyond this is required for Course IV, while

the first year's work of the General Scientific Course (VI) includes a review of the Mathematics of the Senior Preparatory.

In the Engineering Courses the ultimate intention of the student is prominently kept in mind, and such points as have an especial bearing upon his technical work are emphasized as occasion may suggest. The tendency, however, too frequently observable in technical schools, to cramp the Mathematical instruction within the limits of a meagre preparation for professional work, is avoided, and the treatment of each subject is, in general, designed to be as broad and full as may be in the allotted time.

At the same time that the facts are taught, the utility of mathematical study as a mental discipline is duly recognized, and an effort is made to promote habits of exact, logical reasoning, and to stimulate originality and independence of thought.

The Junior Class meets five times a week; the Intermediate and the Senior each three times.

At each meeting, the class is examined on matter previously assigned, and, when expedient, explanations of the text and supplementary lectures and notes are given. The student is constantly exercised in work at the black-board, reproducing demonstrations and applying demonstrated principles to the solution of special examples.

JUNIOR CLASS.

The Junior Class studies Trigonometry, Plane and Spherical, throughout the first half of the year. The class is thoroughly drilled in the Fundamental Definitions and Formulæ. The construction and use of Logarithmic tables are taught, and numerous examples in the solution of triangles, involving the use of Logarithms are given. Occasionally actual heights and distances are required to be calculated by Trigonometric methods.

The second half of the year is taken up with the study of the Conic Sections and a few of the Higher Plane Curves.

TEXT BOOKS.—Snowball's Trigonometry (Plane and Spherical), Wentworth's Analytic Geometry. *For Reference.*—Todhunter's Plane and Spherical Trigonometry, Puckle's Conic Sections, Todhunter's Conic Sections, Searle's or Henck's Field Book.

This class is uniformly required in Courses I, II, III, V and VI.

INTERMEDIATE CLASS.

The class begins with Analytic Geometry of Three Dimensions, studying only surfaces of the second degree—the conicoids. The Differential Calculus is then taken up, and the principles arrived at are applied in the development of functions, the solution of problems of maxima and minima, the investigation of the properties of curves, and the tracing of curves from their equations. In the Integral Calculus, the elementary formulæ of integration are developed and applied to numerous examples, and considerable attention is paid to the use of Definite Integration in the rectification of curves, the quadrature of surfaces and the cubature of volumes.

TEXT BOOKS.—Venable's Notes on Solid Geometry, Williamson's Differential Calculus, Williamson's Integral Calculus. *For Reference.*—Todhunter's and Salmon's Mathematical works and the Mathematical articles in the Encyclopædia Britannica.

The above is required in Courses II, III and V. For students of Mining Engineering (Course I) a briefer treatment of the same subjects extending through one term is given. This will include such a short discussion of Analytic Geometry of Three Dimensions as is found in Wentworth's An. Geometry, and in Calculus some such work as Taylor's "Elements of the Calculus," or notes by the professor.

SENIOR CLASS.

The work of this class is designed only for students who are taking the special Course in Mathematics and Physics (V), and such others as may wish to extend their Mathematical

studies beyond the usual undergraduate range. The course will be susceptible of a certain amount of variation from year to year, at the Professor's discretion, to meet the needs and accord with the purposes of the applicants. It will include selected portions of some of the following subjects: Projective Geometry, Theory of Equations, Determinants, Differential Equations, Quaternions.

TEXT BOOKS.—Cremona's Projective Geometry, Todhunter's Theory of Equations, Muir's Theory of Determinants, Forsyth's Differential Equations, Kelland and Tait's, and Tait's Quaternions.

Lectures on the history of Mathematics are given during the year.

A collection of the chief works on Mathematics in English, French and German, which is contained in the Library, affords the student an opportunity of extending his research at will.

A class of two now engaged in this work has reviewed Williamson's Differential and Integral Calculus, has read Muir's Determinants, and Kelland and Tait's Introduction to Quaternions, with certain chapters of Tait's more advanced treatise, and will, before the end of the session, take the earlier part of Forsyth's Differential Equations.

ACADEMIC COURSE.

Mr. Drake and Mr. Wilkins.

THE following Academic Course of study was established in pursuance of an act of the Legislature of Missouri, 1887. It is designed to make the course equal in every respect to those offered at the best academies. As now arranged, it will commend itself especially to young men who wish to fit themselves for successful business or professional life, and to teachers who wish to prepare for the higher work in their calling.

LANGUAGE, LITERATURE AND HISTORY.

German.—The course extends through two years, and consists of exercises in translation and conversation, and of a study of the gems of German literature. An effort is made, first of all, to give the student a thoroughly practical knowledge of the language. In addition to this, technical students may acquire such facility in translation as will enable them to read German scientific works in the original. The excellent mental discipline that may be derived from the study of a foreign language, and the great aid that such study may afford to the understanding of one's own language, is not overlooked.

French.—The main object of the course in French is to give the student a practical reading knowledge of the language. The first year is devoted to the study of French grammar and to the reading of portions of Le Roman d'un Jeune Homme Pauvre and La Petite Fadette. During the second year the student's attention is given to reading scientific and dramatic French and to lectures on the history and literature of the language.

ENGLISH GRAMMAR.—A familiarity with forms and with principles of construction is insisted upon. Written exercises are required daily, from the belief that painstaking practice under proper supervision is the best, if not the only, means of acquiring facility in the use of good English.

TEXT BOOK.—Harvey's Grammar.

COMPOSITION AND RHETORIC.—It will be seen that this subject follows immediately, as it naturally should, upon that of Grammar. The student is required to practice letter writing at the very beginning of the work. From this style of composition to others, the steps are taken with ease. Instruction is given with a view to practical results: it is designed not only to impart a knowledge of principles, but also to develop a facility in the application of them.

TEXT BOOK.—Hill's Elements of Rhetoric and Composition.

ENGLISH LITERATURE.—An attempt is made to lead the student to form a correct estimate of the literary value of English productions, and also to direct his attention to the peculiar social and political conditions of which the literature of any particular period is an expression. In this regard, this course and that in English History are made to supplement each other. Time is given to a study of the masterpieces from Chaucer's time to the present, and to a perusal of standard authorities on the literatures of the language. The library is well supplied with works of reference.

TEXT BOOK.—Shaw's History of English and American Literature.

ENGLISH HISTORY.—It will be seen that this subject and that of English Literature are pursued during the same term. The two are so intimately associated that the importance of this arrangement can hardly be overestimated. An effort is made to present the subject of English History in a manner that shall illustrate the great law of national growth, in the light thrown upon it by the foremost English historians. The library contains the works of many of the leading authorities on this subject.

TEXT BOOK.—Montgomery's "The Leading Facts of English History."

GENERAL HISTORY.—It is designed to give the student a knowledge of the outlines of the world's history that may serve as a good foundation for further historical and literary work.

TEXT BOOK.—Myers' General History.

AMERICAN HISTORY.—An attempt is made to impart a knowledge of the causes and effects of the important events of history rather than to fill the mind of the student with an undigested mass of detail. Especial attention is given to the history of our country under the constitution. The drawing of historic maps, recitations from topics assigned, and frequent written reviews, are important features of the work.

TEXT BOOK.—Barnes's Brief History of the United States.

CIVIL GOVERNMENT.—The text book now in use (Young's Class Book) gives an analysis of the Constitution of the United States, presents a comparative view of the different State governments, treats of county and township organization, and affords an acquaintance with such principles of law as are involved in ordinary business transactions.

POLITICAL ECONOMY.—Practical exercises constitute an important feature of the text book used. No attempt is made to inculcate any particular economic doctrine, but it is sought to give the student such an understanding of the principles of the science that he may apply them intelligently to the solution of such questions as may come under his consideration.

TEXT BOOK.—Chapin's First Principles of Political Economy.

MATHEMATICS.

PROF. RICHARDS, MR. WILKINS, AND MR. DEAN.

The Academic Course in Mathematics begins with Higher Arithmetic and is continued through Algebra and Geometry. To Arithmetic one term is devoted, to each of the last, two. Students who can produce satisfactory evidence of a sufficient

knowledge of Arithmetic will not be required to pursue that study. The object of the course is to give the student a comprehension of the principles involved in the elementary branches and a thorough acquaintance with their immediate application. The solution of original problems, so valuable both as an exercise and a test of acquirement, is made a prominent feature of the course.

In Arithmetic the vital principle and not the mere mechanical rule is what is sought to be inculcated, and the working of examples is a means not an end. Incidentally short methods of multiplication and division are introduced and insisted upon. In algebra, the course begins with the fundamental operations and extends through Quadratic Equations and the Progressions. The class in Geometry completes the usual course in old Geometry, Plane and Solid.

Each class meets daily (five times a week) for one hour. The text books and scheme of work are as follows:

FIRST YEAR.

First Term.—Arithmetic, Barnes' National.
Algebra, Wells' Academic to Simple Equations, containing more than one unknown.

Second Term.—Algebra, Well's Academic, completed.

SECOND YEAR.

First Term.—Geometry, Wells' Plane and Solid, first four books.

Second Term.—Geometry, Wells' Plane and Solid, completed.

The preparation necessary for this course is a good knowledge of Arithmetic to percentage; at the same time some acquaintance with Algebra will greatly facilitate progress.

SCIENCE.

Botany.—The course comprises the elements and principles of descriptive and systematic Botany, together with occasional lectures on the economic uses of various plants. The student is required to begin the analysis of plants as soon as

they begin to bloom in the spring, and to continue analyzing till the end of the term. Frequent botanical excursions by the class are insisted on for the purpose of familiarizing the student with the haunts and habits of all the common plants of the vicinity.

TEXT BOOK.—Gray's School and Field Book.

CHEMISTRY.—The design of this course is to acquaint the student with the most important facts and principles of the science without going into minor details. Instruction is given by lectures, illustrated by means of experiments, and by recitations based upon the subject matter contained in Norton's Elements of Chemistry, Revised Edition. The class meets five times each week throughout the second term.

PHYSIOLOGY.—It is aimed to make the instruction in this branch as practical as possible, and to lead the student to obey the injunction "Know Thyself." Hints on hygiene are given, also rules for action in cases of emergency.

TEXT BOOK.—Steele's Hygienic Physiology.

PHYSICS.—In this course the object constantly held in view is to present simply and plainly the fundamental truths of Natural Philosophy; to define clearly the nature of force and of motion, and the laws which they obey; and to teach the student to apply these laws to the solution of such simple problems of statics and dynamics as relate to common and familiar phenomena. The subjects of sound, light, heat and electricity are introduced upon a scientific basis and are illustrated throughout the course by experiments. The department is supplied with apparatus of all kinds necessary for this purpose. For academic students the course extends through the first term of the second year.

PHYSICAL GEOGRAPHY.—In this branch attention is directed to the causes of natural phenomena. Meteorology and the signal service receive special attention.

TEXT BOOK.—Guyot's Physical Geography.

BOOK-KEEPING.—This study is not required, but will be taught upon the application of at least five students for in-

struction therein. The course comprises principally Double Entry. Various kinds of business are represented, and all the modern conveniences and auxiliaries are explained and used. The student is required to finish at least six different sets of books. Those who complete these before the end of the term will be furnished with abundant material for further practice.

PREPARATORY COURSE.

This course of study is maintained for the benefit of those students who find it necessary to give themselves special preparation for the advanced courses. The completion of this course admits the student to any of the advanced courses without examination.

CHEMISTRY.—This course is intended to prepare Technical students for Laboratory work, which begins in the second year. Norton's Elements of Chemistry, Revised Edition, is the text book used. The class meets five times each week.

PHYSICS.—In this class, which meets five times each week throughout the year, the foundation is laid for the course in Mechanics of the Technical Department. The fundamental ideas and laws of force, motion, energy and work are dwelt upon at length, and great care is taken to convey to the student correct and sound notions on these important points. The subjects of sound, light, heat and electricity are then taken up, the laws which they obey given and explained simply and clearly. A prominent feature of the course is experimental illustration, for which purpose the equipment in apparatus is excellent.

MATHEMATICS.—A thorough knowledge of elementary Algebra and Geometry is absolutely essential to any successful prosecution of the higher branches of Mathematics, and this course is framed to give those who are insufficiently prepared in these subjects an opportunity to obtain the requisite acquaintance with them. The studies of the first year and the text books used are the same as those already laid down in the Academic Department (p. 41). The special feature

of the second year's work is an extended course in Algebra. This will include a hurried review of the elementary processes, a wider discussion of problems leading to equations with the interpretation of their results, Theory of Exponents, Surds, Imaginaries, the Progressions, Permutations and Combinations, Binomial Theorem, Series, Logarithms, Theory of Numbers, with an introduction to the Theory of Equations.

TEXT BOOKS.—Wells' University Algebra, with lectures.

At the same time the class takes a thorough course in the old—Euclidian—Geometry, with numerous original exercises. Text Book, Wells' Plane and Solid Geometry.

This is recognized as an important period in the student's work, and every effort is made to have him acquire that firm basis without which his subsequent superstructure cannot be stable. His attention is called to the logical processes involved in the demonstrations, and an attempt is made to have him apply the same rigorous methods to his own thought. Principles learned are constantly illustrated and impressed by requiring their application to the solution of problems. Incidentally the student is acquainted with the noteworthy facts in the origin and development of the subject which he is studying.

GENERAL INFORMATION.

BUILDINGS AND EQUIPMENTS.

THE buildings of the School of Mines are situated in the most elevated part of the city of Rolla. They are substantial brick structures, well ventilated and lighted, and heated by the best furnaces manufactured. The main building has recently been painted and kalsomined throughout, and the laboratory, one of the most complete in the country, has been in use but four years.

The different departments of the School are well supplied with apparatus. Several hundred dollars have been expended this year in the purchase of instruments and apparatus for the Engineering and Chemical departments, and further purchases will be made as additional needs are felt and the financial condition of the School will allow.

The last General Assembly appropriated five thousand dollars to the School of Mines for a Mess club house. The building is now completed and contains commodious and comfortable rooms for thirty young men. The dining hall and culinary department accommodate twice that number. The students in the building form themselves into a club, and employ their own caterer. In this manner it is believed they will be able to board themselves at comparatively low cost.

Students wishing to engage rooms in the club building for the session of 1891-92, should do so before September 1, 1891, as the supply of rooms will soon be exhausted. Two students occupy one room. Students engaging rooms on or before September 1, should send $5 to the treasurer of the College in order to secure assignment to room. This will be refunded

on occupation or failure to do so, and is merely required as evidence of good faith in requesting reservation of a room. The club will be organized immediately at the beginning of the session.

LIBRARY.

The Library contains 2,100 volumes. There have recently been added about four hundred volumes on Engineering, Mathematics, Chemistry and Metallurgy. The library is now supplied with the latest works on these subjects, and any student who may wish to pursue an extended course of reading in connection with his class work has here an ample opportunity. There are also the standard works in English and American poetry, fiction, biography, and history, provided with especial view to the needs of Academic students. About twenty Engineering, Mathematical and Chemical journals, domestic and foreign, are kept on file for the use of Faculty and students.

The library is open at regular hours, and all students of the institution may use the books, under certain regulations.

EXAMINATIONS.

Students applying for the degrees led to in Courses I to V inclusive, must stand examinations on the elements of Algebra and Geometry before being admitted to the work of those courses.

This examination is only intended to test the student's fitness for this advanced work. No entrance examinations are held for admittance to the School of Mines.

Besides the daily oral examination upon the previous lecture, two general written examinations of each class are held during the session, which every member is required to stand. The Intermediate Examination occurs near the middle of the session, and is upon the subjects of instruction of the first part of the course. The Final Examination occurs near the end of

the session, and is upon the subjects of instruction of the second part of the course only, or upon those of the entire course. These examinations are conducted in writing. The questions have numerical values affixed. If the answers at any general examination amount in value to three-fourths of the aggregate value of the questions, a distinction is awarded to the student, and the fact is published at the close of the session. Examinations for Proficiency or for Graduation coincide with the Intermediate and Final Examinations.

The written examinations are conducted in each school by the Professor. They are sufficiently comprehensive and difficult to render it impossible for a student, without steady diligence, to attain a distinction, and candidates for Proficiency or for Graduation are subjected to searching interrogations on the details as well as on the general principles of the subject, and are expected to be accurately versed in all matters treated in the lectures and correlative text. Moreover, the student's command of English, and his standing at both daily and general examinations are taken into account in estimating his qualification for the certificate or diploma.

DEGREES.

A Certificate of Distinction is conferred on one who has attained three-fourths of the value of the questions at an Intermediate or Final Examination. For the degrees of Proficient or Graduate, an equal or higher standard is demanded; these degrees which are conferred only on examination are as follows.

UNTITLED DEGREES.

1. A CERTIFICATE OF PROFICIENCY is conferred on one who has passed examination on any of the following special courses: Geology and Mineralogy, General Chemistry, Fire Assaying, Botany and Zoology, Elementary Physics, Geodesy, the Academic course, and the Preparatory course.

2. A DIPLOMA OF GRADUATION is conferred on one who has passed examination on any of the following general courses: Mathematics, Physics, Analytical Chemistry, Engineering, and Assaying.

SCIENTIFIC DEGREES WITH TITLES.

1. The degree of BACHELOR OF SCIENCE IN MATHEMATICS AND PHYSICS is conferred upon one who has passed examination on all of the subjects of instruction in the Course of Mathematics and Physics.

2. The degree of BACHELOR OF SCIENCE IN CHEMISTRY is conferred on one who has passed examination on all of the work of the special Chemical Course.

3. The degree of BACHELOR OF SCIENCE IN GENERAL SCIENCE is conferred on one who has passed examination on all of the prescribed subjects of instruction in the General Course.

PROFESSIONAL DEGREES WITH TITLES.

1. The degree of BACHELOR OF SCIENCE IN CIVIL ENGINEERING is conferred on one who has passed examination on all of the subjects of instruction in the Civil Engineering Course.

2. The degree of BACHELOR OF SCIENCE IN MINING ENGINEERING is conferred on one who has passed examination on all of the subjects of instruction in the Mining Engineering Course.

3. The degree of BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING is conferred on one who has passed examination on all of the subjects of the Mechanical Engineering Course.

4. The degree of CIVIL ENGINEER, MINING ENGINEER or MECHANICAL ENGINEER is conferred on one who, having graduated in Civil, Mining or Mechanical Engineering and received the Bachelor's Degree therein, has identified himself with the profession during a period of not less than three years, and during that time has demonstrated by work his fitness for his chosen profession.

COMMENCEMENT.

The annual Commencement exercises are held in the Assembly room, at the close of the work in June. The exercises consist of an address by some prominent speaker, the conferring of degrees and granting of diplomas by the Director, and an essay or oration by some member of the graduating class.

Last year the address was delivered by Mr. Lee Meriwether, Labor Commissioner of Missouri.

EXPENSES.

The necessary expenses for the session of nine months in the School of Mines is as follows:

Matriculation, *payable on entrance*, ...	$10.00
Library fee, *payable on entrance*, ...	4.00
Board, including fuel, washing, lights, etc., .	$95.00 to 135.00
TOTAL, ...	$109.00 to $149.00

The cost of books and stationery (too variable to be introduced into a general estimate) may be assumed to average $10.00 during the session.

All laboratory students furnish their own blowpipes, platinum, silver and gold solutions, crucibles, and apparatus, and pay for gas and fuel consumed and for apparatus damaged or destroyed. A deposit of five dollars per term, covering the value of the apparatus and chemicals issued, is required to be placed in the hands of the Treasurer by each laboratory student. This deposit, less the value of material consumed, is returned at the close of the year.

It is believed that mess-club students will be able to cover the expenses of board, lodging, washing, lights and fuel with $10.00 per month; students boarding in the city pay from $12.00 to $15.00 per month.

An abatement of one-half the fees for Matriculation and Library is made to students who enter after 1st of January.

MONTHLY REPORTS.

Regular monthly reports are sent to the parents or guardian of each student showing the student's grade in scholarship for the month, and giving such other information in regard to his progress, attendance, etc., as may be thought to be of interest. The attention of parents and guardians is particularly called to these reports.

The Missouri School of Mines now offers advantages which it has not been able to offer before in way of accommodation and thoroughly organized system of scientific work. The increase in the number and grade of its students the past two years is evidence of a higher appreciation of its work, in both Missouri and neighboring States. Every effort is being put forth by all connected with the institution to make it fulfill the purpose of its establishment, i. e., to furnish thorough instruction in Mechanical, Mining and Civil Engineering, and to fit young men of Missouri for the industrial pursuits.

SCHEME OF LECTURES, PROFESSIONAL COURSES.

	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.
9–10	Jr. Chemistry. Int. Eng.	Sr. Metallurgy. Int. Eng.	Jr. Chemistry. Int. Eng.	Sr. Metallurgy. Int. Eng.	Jr. Chemistry. Int. Eng.
10–11	Jr. Math. Int. Chem. Tech. Sr. Civil Eng.	Jr. Math. Min. and Geo. Sr. Mining Eng.	Jr. Math. Int. Chem. Tech. Sr. Civil Eng.	Jr. Math. Min. and Geo. Sr. Mining Eng.	Jr. Math. Int. Chem. Tech. Sr. Civil Eng.
11–12	Jr. Eng. French. Int. Math.	Jr. Eng. French. Sr. Math.	Jr. Eng. French. Int. Math.	Jr. Eng. French. Sr. Math.	Jr. Eng. French. Int. Math.
2–4	Drawing. Laboratory. Field Work.	Drawing. Laboratory. Field Work.	Drawing. Laboratory. Field Work.	Drawing. Laboratory. Field Work.	Drawing. Laboratory. Field Work.

TIME-TABLE FOR THE ACADEMIC AND PREPARATORY COURSES.

FIRST TERM.

9–10	10–11	11–12	1–2	2–3	3–4
French, (First year).	English Literature.	U. S. History.		French, (Second year).	English History.
German, (First year).	Arithmetic.	Physics.		German, (Second year).	English Grammar.
Algebra, (Second year).					Geometry.
Algebra, (First year).					

SECOND TERM.

French, (First year).	Civil Government, (Half hour).	General History.	Book-keeping.	French, (Second year).	Rhetoric.
German, (First year).	Political Economy, (Half hour).	Physical Geography. (Half hour).		German, (Second year).	Botany.
Algebra, (Second year).		Physiology, (Half hour).			Geometry.
Algebra, (First year).	Physics.	Chemistry.			

SCHEME OF EXAMINATIONS.

INTERMEDIATE EXAMINATIONS FOR 1892.

Algebra, Junior Engineering, Mineralogy, ...	Monday, January	25.
Metallurgy, German, English Literature and Arithmetic, ...	Tuesday, "	26.
French, General Chemistry, Chemical Technology and History, ...	Wednesday, "	27.
Intermediate Engineering and Geometry, ...	Thursday, "	28.
Junior Mathematics and Physics, . .	Friday, "	29.
Intermediate Mathematics, Zoology, and Senior Engineering, ...	Saturday, "	30.

FINAL EXAMINATIONS FOR 1892.

French, ...	Monday, June	1.
Metallurgy, German, Civil Government and Political Economy, ...	Tuesday, "	2.
General Chemistry, Chemical Technology and History, ...	Wednesday, "	3.
Intermediate Engineering, Geometry, and Physical Geography, ...	Thursday, "	4.
Junior Mathematics, Physics, Rhetoric,	Friday, "	5.
Intermediate Mathematics, Senior Engineering, Botany and Physiology, . .	Saturday, "	6.
Algebra, Junior Engineering and Geology, ...	Tuesday, "	9.

CALENDAR.

1891.

June 11, Thursday, 10 A. M.,	Annual Commencement.
September 14, Monday,	First Term Begins.
September 14 and 15,	Entrance Examination.
December 18, Friday,	Christmas Holidays Begin.

1892.

January 5, Tuesday, 9 A. M.	Exercises Resumed.
January 25, Monday,	Examinations Begin.
January 30, Saturday,	Examinations Close.
February 2, Tuesday, 9 A. M.	Second Term Begins.
June 1, Monday,	Final Examinations Begin.
June 9, Tuesday,	Final Examinations End.
June 11, Thursday, 10 A. M.	Annual Commencement.

CATALOGUE OF STUDENTS.

1.	Alexander, Thompson,	Fort Smith, Ark.
2.	Bland, R. E.	Phelps Co.
3.	Bolles, F. C.	Phelps Co.
4.	Bowles, Chas.	Phelps Co.
5.	Bradford, H.	Texas Co.
6.	Buskett, E. W.	Phelps Co.
7.	Buskett, Mary,	Phelps Co.
8.	Buskett, Nancy,	Phelps Co.
9.	Campbell, Catharine,	Phelps Co.
10.	Cansler, Augusta,	Phelps Co.
11.	Case, A. B.	Dent Co.
12.	Clark, G. C.	Greene Co.
13.	Conant, A. J.	New York.
14.	Cornwall, H.	St. Louis.
15.	Dean, Geo. R.	Waterloo, Ill.
16.	Deegan, Agnes,	Phelps Co.
17.	Donahoe, Maymie,	Phelps Co.
18.	Duncan, F. E.	Phelps Co.
19.	Dwyer, E. P.	Jasper Co.
20.	Dyer, Temple,	Phelps Co.
21.	Faulkner, M. F.	Phelps Co.
22.	Flett, W. A.	Dent Co.
23.	Florreich, Philip,	St. Louis.
24.	Fort, Nellie,	Phelps Co.
25.	Fox, Homer,	St. Louis.
26.	Grove, C. D.	Daviess Co.
27.	Heller, Sam'l,	Phelps Co.
28.	Hellmuth, G. W.	Phelps Co.

29.	Henderson, H. P.	Phelps Co.
30.	Herdman, Geo.	Neosho Falls, Kan.
31.	Hume, A. P.	Washington, D. C.
32.	Hutson, W. E.	Orlando, Fla.
33.	Holman, W. P.	Dent Co.
34.	Jackling, D. C.	Pettis Co.
35.	Jackson, J. M.	New Mexico.
36.	Jamison, Blanche,	Phelps Co.
57.	Johnson, E. M.	Phelps Co.
38.	Johnson, W. A.	St. Louis.
39.	Jones, F. A.	Jackson Co.
40.	Jones, H. I.	St. Louis.
41.	Kelly, C. M.	Johnson Co.
42.	Kriehn, E.	Lafayette Co.
43.	Lewis, H. E.	St. Louis.
44.	Lowe, P. L.	Jackson Co.
45.	Mansbridge, Elizabeth,	Phelps Co.
46.	McAfee, C. B.	Greene Co.
47.	McAfee, J. R.	Greene Co.
48.	McCaw, E.	Phelps Co.
49.	McCaw, Maggie,	Phelps Co.
50.	Millard, Linna,	Phelps Co.
51.	Millard, Mary,	Phelps Co.
52.	Millard, Sallie,	Phelps Co.
53.	Mitchell, Maude,	Phelps Co.
54.	Morgan, Minnie,	Phelps Co.
55.	Morris, Lola,	Phelps Co.
56.	Morrow, S. L.	Fort Smith, Ark.
57.	Murray, M. B.	Christian Co.
58.	Madigan, Fannie,	Phelps Co.
59.	Power, John,	Wichita, Kans.
60.	Reid, John,	Pleasanton, Kans.
61.	Richardson, Ethelyn,	Phelps Co.
62.	Sappenfield, Estella,	Phelps Co.
63.	Sappenfield, Olive,	Phelps Co.
64.	Schmook, Otto,	Greene Co.
65.	Schwietzer, Geo.	St. Louis.
66.	Seamon, F. H.	Wheeling, W. Va.

67. Shineman, L. . . . . Phelps Co.
68. Simmonds, A. G. . . . . Greenville, N. J.
69. Southgate, Maggie, ... Phelps Co.
70. Spencer, C. B. . . . . Jasper Co.
71. Stewart, A. J. . . . . Victoria, New Mex.
72. Strine, A. T. . . . . Phelps Co.
73. Strobach, Minnie, ... Phelps Co.
74. Sutter, H. M. . . . . Greene Co.
75. Thomas, W. S. . . . . Macon Co.
76. Tyrrell, F. L. . . . . Dent Co.
77. Wade, A. . . . . Montana.
78. Wippern, C. A. . . . . St. Louis.
79. Wood, Minerva, ... Phelps Co.
80. Young, Marshall, ... St. Louis.

SUMMARY.

COUNTIES.		STATES.	
Christian,	1	Arkansas,	2
Daviess,	1	Florida,	1
Dent,	4	Illinois,	1
Greene,	5	Kansas,	3
Jackson,	2	Missouri.	66
Jasper,	2	Montana,	1
Johnson,	1	New Jersey,	1
Lafayette,	1	New Mexico,	2
Macon,	1	New York,	1
Pettis,	1	West Virginia,	1
Phelps,	37	Washington, D. C.	1
St. Louis,	9		
Texas,	1	Total,	80
Total,	66		

GRADUATES.

1874.

John W. Pack, M. E.—Assistant Assayer, U. S. Mint, San Francisco, Cal.

Gustavus H. Duncan, C. E.—Boulder, Colo.

*John H. Gill, C. E.—U. S. Engineering Dep't, Washington, D. C.

1875.

Almon W. Hare, M. E.—Chemist and Assayer, Aspen, Colo.

Francis J. Deegan, C. E.—Engineer Louisville, New Orleans and Texas Railway.

1876.

John E. McGrath, C. E.—Sub-assistant, U. S. Coast and Geodetic Survey, San Francisco, Cal.

William C. Minger, M. E.—Assayer and Chemist, Pueblo, Colorado.

Cyrus H. Emerson, C. E.—Denison, Tex.

Oscar E. Garvens, M. E.—Lead City, Dakota.

John D. Greason, M. E.—Assistant Engineer and Right-of-Way Agent, D., M. and A. R. R.

1877.

A. H. Ohmann-Dumesnill, M. E.; M. D., St. Louis Medical College, '80.—Since '83, Professor of Dermatology and Syphilography, St. Louis College of Physicians and Surgeons. Vice-President of Ninth International Medical Congress, '87.

James A. Pack, M. E.—Assayer, Butte City, Montana.
*Thomas H. Milsaps, C. E.

1878.

Wilton R. Brown, M. E.—Assayer for Shakespeare Gold and Silver Mining Co., Shakespeare, New Mexico.
Lee R. Grabill, M. E.—Assistant Engineer U. S. River and Harbor Improvement, Washington, D. C., and Fredericksburgh, Va. Superintendent of Battery Station, U. S. Fish Commissioner, Havre de Grace, Maryland, '85-6.
William Y. Bean, C. E.—Engineer Missouri Pacific Railway.
*Lindsay L. Coppedge, C. E.—Engineer Missouri Pacific Railway.

1879.

Charles F. Winters, M. E.—Assayer, New Mexico.
Rudolph C. Hoyer, C. E.—Draughtsman, U. S. Engineer's office, Memphis, Tenn.

1880.

Arthur Carson, M. E.—Assayer, Butte City, Montana.
Lorin X. Smith, M. E., C. E.—Mining Engineer, Silver City, New Mexico.

1881.

Edward B. Summers.—Engineer Missouri Pacific Railway '81. U. S. Topographical Survey, '86. Engineer Kansas City, Wyandotte and Northern Railway.
Walter Wishon.—Denver, Colorado.

1882.

Frank W. Gibb, C. E., M. E.—Mining Engineer, Assayer and Chemist, Little Rock, Ark. Associate American Institute of Mining Engineeers.
W. R. Painter, C. E.—County Surveyor, Moberly, Mo.
A. B. Schrantz, C. E.—Engineer Union Pacific Railway.
H. N. Van Devander, C. E.—Engineer St. Louis and San Francisco Railway, '82-3. Engineer Anniston and Atlantic

Railway, '83-4. Now Superintendent R. M. & M. Co.'s Iron Mines, Priors, Georgia.

B. Ross, M. E.—Editor, Houston, Mo.

1883.

Floyd Davis, C. E., M. E.; M. Sc., Adrian College, '84; Ph. D., Miami University, '88. Professor of Chemistry and Metallurgy, Virginia Agricultural and Mechanical College, '83-6.—Lecture on Assaying and Metallurgy, Dakota School of Mines, '87. Now Professor of Chemistry and Physics, Drake University; Chemist of Iowa State Board of Health; and non-resident Professor of Metallurgy, Wisconsin State University.

1884.

Curtis Alexander, C. E., M. E.—Assistant Division Engineer Leavenworth, Northern and Southern Railway, '86–7.—Chemist for U. S. Antimony Company, '87–8.—Now Assayer and Chemist for Mexican Ore Company, Laredo, Texas.

W. M. Claypool, C. E., M. E.—Chemist, Fairbank, Arizona.

P. C. Gallaher, M. E.—Assayer and Chemist, Leadville, '84–7. Sup't of Minnie Mine, Breckenridge, Colorado, '87–8. Now Assayer and Chemist, Aspen, Colorado.

A. Neustaedter, M. E.—Office of President of Board of Public Improvements, St. Louis, Mo. Now Sup't of St. Genevieve Copper Works, St. Genevieve, Mo.

Frank Wilson, C. E.—Engineer St. Louis and San Francisco Railway.

1885.

*J. R. D. Owen, M. E.—Chemical Laboratory School of Mines.

P. R. Van Frank, M. E.—Assistant Engineer Verdigres Valley, Independence and Western Railway.

F. C. Wilson, C. E.—Resident Engineer Burlington and Northern Railway. Division Engineer Union Pacific Railway. Now Resident Engineer for Atlanta Bridge Co., Atlanta, Ga.

1886.

J. G. Martinez, M. E.—Assistant Chemist, Coahuilo, Mexico. Now in the employ of the Mexican International Railway.

Jay Cullens, C. E.—Engineer Union Pacific Railway.

James E. Fulcher, C. E.—Draughtsman Missouri Pacific Railway, '86. Draughtsman St. Louis and San Francisco Railway, '87. Now Principal of Akinsville Normal and Commercial Institute, Akinsville, Mo.

1887.

O. Lachmund, M. E.—Chemist for Western Steel Co., St. Louis, '87. Bullion Sampler for Holden Smelting Co., Denver. Now employed by Grand View Mining and Smelting Co., Rico, Colorado.

W. M. Yeater, M. E.—Chemist for Western Steel Co., St. Louis, Mo., '87. Assayer for Gold King Mine, Telluride, Colorado. Now City Engineer, Sedalia, Mo.

G. W. Colo, C. E.—U. S. Coast Survey. Now Engineer Missouri Pacific Railway.

George B. Wiles, C. E.—Engineer Missouri Pacific Railway. Now employed by St. Louis Bridge and Iron Company, St. Louis, Mo.

Mary Kyle, Academic.—Teacher, Troy, Ohio.

1888.

Elizabeth Harrison, Academic.—At home, Rolla, Mo.

Minerva G. Seay, Academic.—Teacher, West Plains, Mo.

1889.

Anielka Illinski, Academic.

1890.

Geo. R. Dean, C. E.—Instructor in Mathematics and Physics, Missouri School of Mines.

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*Dead.

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